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STRATIGRAPHY OF THE NEOPROTEROZOIC TENT HILL FORMATION AND SIMMENS QUARTZITE AT SOUTH TENT HILL ON THE STUART SHELF, SOUTH AUSTRALIA

by IAN A. DYSON*

Summary

DYSON, I.A. (1996) Stratigraphy of the Neoproterozoic Tent Hill Formation and Simmens Quartzite at South Tent Hill on the Stuart Shelf, South Australia. *Trans. R. Soc. S. Aust.* **120**(3), 117-129, 29 November, 1996.

The Tent Hill Formation and Simmens Quartzite represent regressive, shallow marine sedimentation of the Sandison Subgroup on the Stuart Shelf. At South Tent Hill, the Tent Hill Formation comprises the Tregolana Shale, Lincoln Gap Siltstone and Corraberra Sandstone members and represents deposition in a storm-dominated shelf environment. Sharp-based, swaley cross-stratified sandstone beds of the Corraberra Sandstone Member are interpreted as forced regressive deposits formed above fairweather wave base. The overlying Simmens Quartzite was deposited on a broad, open shelf that was conducive to tidal amplification. These units are correlated with their stratigraphic equivalents in the Adelaide Geosyncline.

KEY WORDS: Stratigraphy, Neoproterozoic, Tent Hill Formation, Simmens Quartzite, Lincoln Gap Siltstone Member, Sandison Subgroup, Stuart Shelf, Adelaide Geosyncline.

Introduction

On the Stuart Shelf, the flat lying sediments of the Tent Hill Formation crop out west of the Torrens Hinge Zone and Adelaide Geosyncline in South Australia. The Tent Hill Formation (Brown 1885) was named after the flat-topped hills 25 km northwest of Port Augusta (Fig. 1). As part of a major study (Dyson 1995[1]), the sedimentology and stratigraphy of the Tent Hill Formation and Simmens Quartzite were investigated in the type section at South Tent Hill (Fig. 2) and represent the first detailed synthesis of the sedimentology and stratigraphy of these formations. This paper revises the stratigraphic nomenclature for the Tent Hill Formation on the Stuart Shelf.

At South Tent Hill, the Tent Hill Formation was formally defined as consisting of three members, namely the Tregolana Shale Member, the Corraberra Sandstone Member and the Simmens Quartzite Member (Dalgarno *et al.* 1968). This study has elevated the Simmens Quartzite Member to formation status and redefined the Corraberra Sandstone Member, thereby incorporating the Lincoln Gap Siltstone Member into the Tent Hill Formation (Fig. 3). The Tent Hill Formation is correlative with the Brachina Formation in the Adelaide Geosyncline. Similarly, the overlying Simmens Quartzite may be correlated with the ABC Range Quartzite. The name "Lincoln Gap Siltstone Member" has been reserved by the Central Register of Australian Stratigraphic Names.

Previous work

The section at South Tent Hill (Fig. 4), originally described by Thomson (1965), was proposed by Dalgarno *et al.* (1968) as the type section for the Tent Hill Formation. The underlying formation was referred to as the "Tregolana shales" by Miles (1955). The term "Lincoln Gap Flagstones" was proposed by Miles (1955) for the sandy succession of the Tent Hill Formation. Crawford (1964) referred to the lower part of this unit as the Corraberra Sandstone. Thomson (1965) defined the Corraberra Sandstone Member and the Simmens Quartzite Member as constituents of the Tent Hill Formation. Coats (1965) correlated the Tregolana Shale Member and Corraberra Sandstone Member with the Brachina Formation, and the Simmens Quartzite Member with the ABC Range Quartzite. Johns (1968) proposed the terms "Woomera Shale Member" and "Arcoona Quartzite Member" on the northern Stuart Shelf where they were considered lateral equivalents of the Tregolana Shale and Simmens Quartzite Members, respectively (Coats 1965).

The stratigraphy of the Tent Hill Formation was reviewed by Coats (1965), Thomson (1965), Johns (1968) and Forbes & Preiss (1987). It was considered to be of Marinoan age by Thomson (1965). However, the sedimentology of the Tent Hill Formation has never been studied in detail and the stratigraphic column of the South Tent Hill section by Thomson (1965) is the only previous attempt to identify and document the sedimentary structures. Johns (1968) considered that the suite of sedimentary structures in

* National Centre for Petroleum Geology and Geophysics, University of Adelaide Adelaide S. Aust 5005.

[1] DYSON, I.A. (1995) Sedimentology and stratigraphy of the Neoproterozoic Sandison Subgroup: a storm-dominated shallow marine sequence in the Adelaide Geosyncline, South Australia. PhD Thesis, Flinders University of South Australia (unpub.)

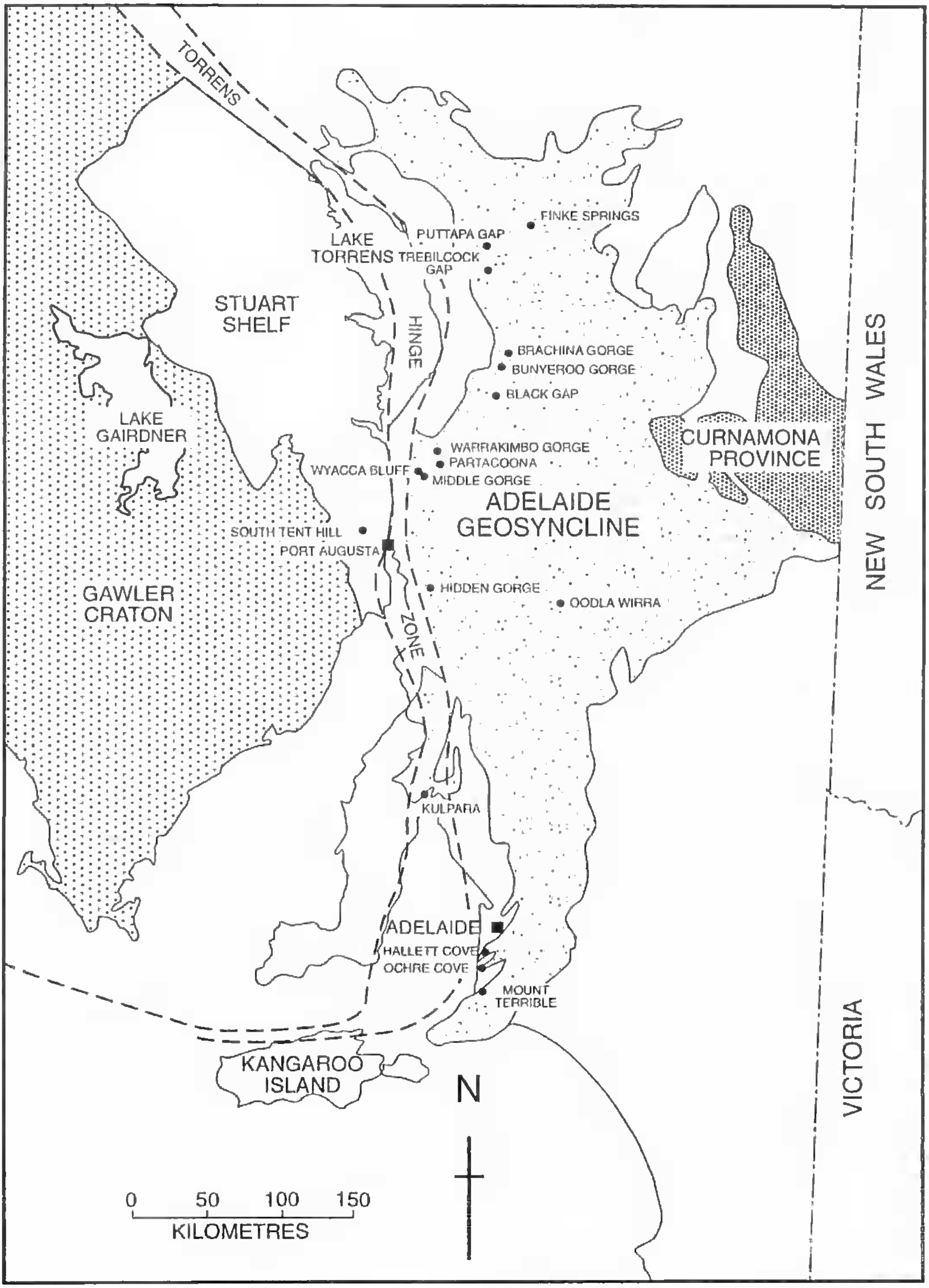
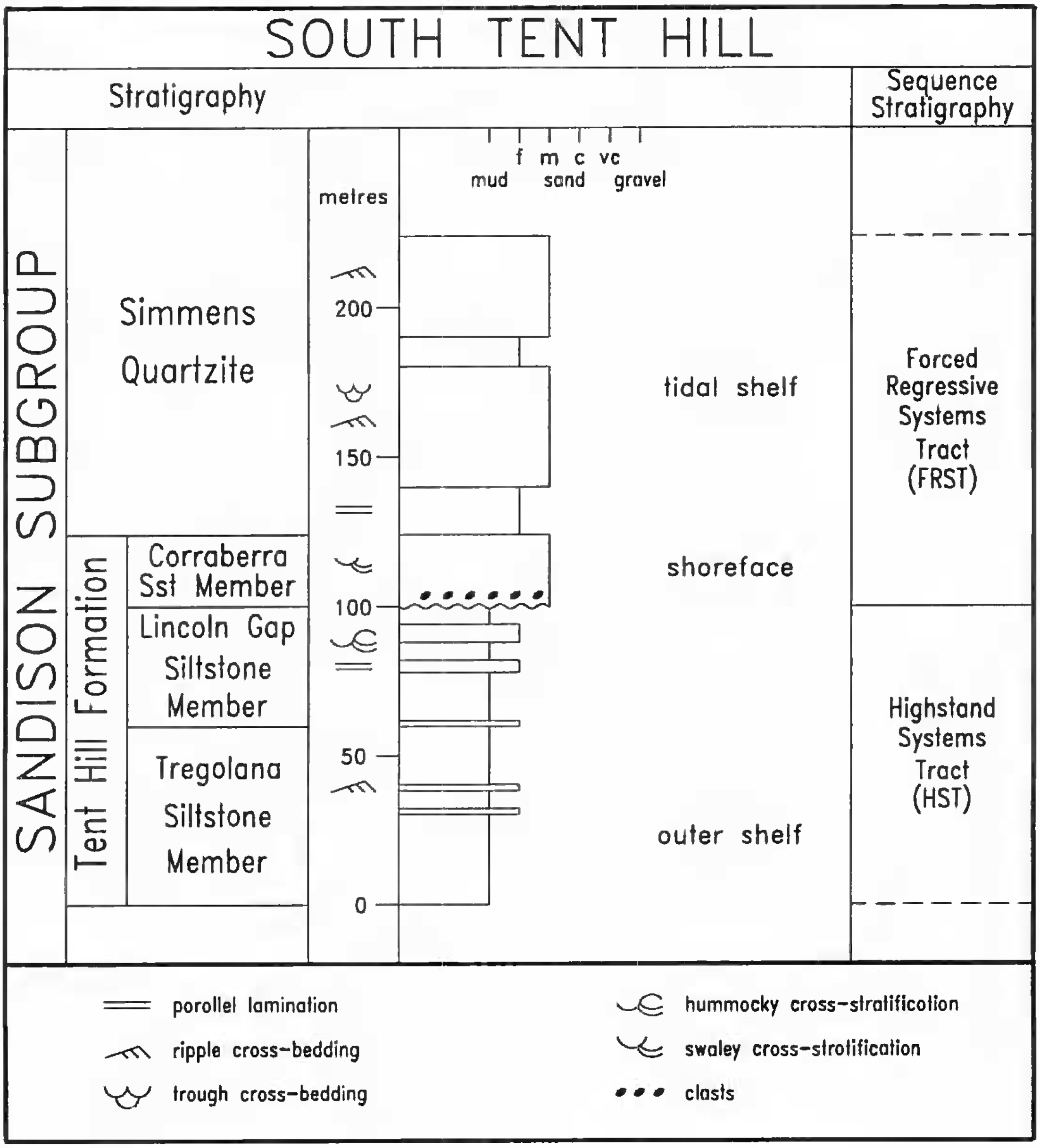


Fig. 1. Tectono-sedimentary provinces in South Australia, showing localities of stratigraphic sections in the Adelaide Geosyncline and their relation to other localities on the Stuart Shelf and in the Torrens Hinge Zone (after Dyson 1995[1]).

Fig. 2. View of the type section for the Tent Hill Formation (Dalgarno *et al.* 1968) on the southern face of South Tent Hill.

Fig. 3. Stratigraphic log of the Simmens Quartzite and Tent Hill Formation at South Tent Hill (after Dyson 1995[1]).



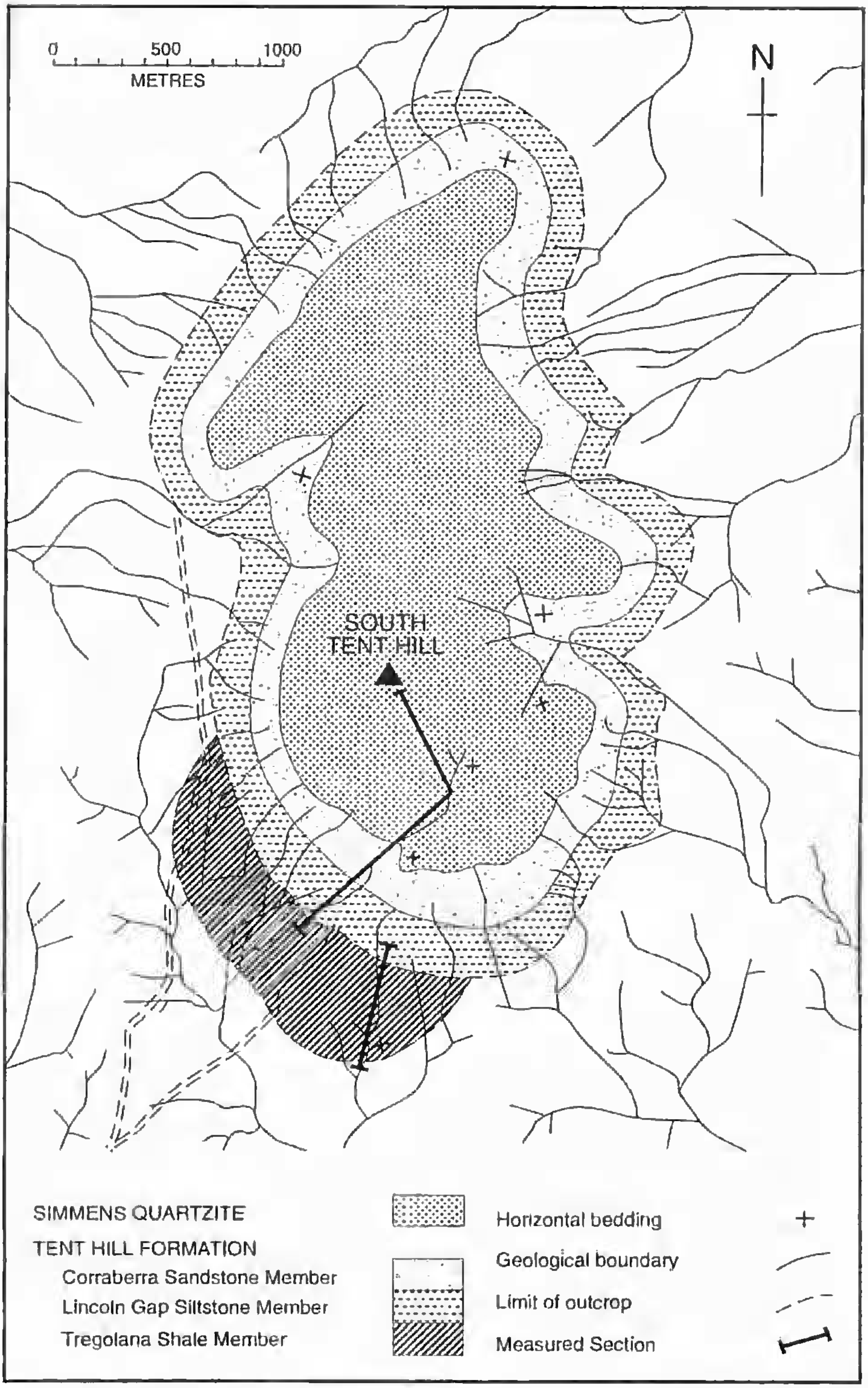


Fig. 4. Geological map of South Tent Hill

the Tent Hill Formation was indicative of strong current action and shallow water sedimentation.

Stratigraphy

The former Simmens Quartzite Member of the Tent Hill Formation is raised herein to formation status to reflect its regional significance. Together, the Tent Hill Formation and Simmens Quartzite (Fig. 3) represent regressive sedimentation of the Sandison Subgroup on the Stuart Shelf. The Sandison Subgroup is an unconformity-bounded depositional sequence in the sense of Mitchum (1977). Dolostone of the underlying Nuccaleena Formation does not crop out in the Tent Hills but is present in drillcore from the Stuart Shelf. It is commonly about 2-6 m thick and displays a sharp to gradational base. The Nuccaleena Formation was deposited below storm wave base on a combined sequence boundary/transgressive surface that represents an hiatal surface of terrigenous starvation. The lower Tent Hill Formation comprises the Tregolana Shale and Lincoln Gap Siltstone members that represent the highstand systems tract of the Sandison Subgroup. An interpreted falling stage or forced regressive systems tract (Dyson 1996a), comprising the overlying Corraberra Sandstone Member of the Tent Hill Formation and the Simmens Quartzite, is placed between the highstand systems tract and the sequence boundary at the top of the Sandison Subgroup (Fig. 3).

The Sandison Subgroup on the Stuart Shelf and in the Adelaide Geosyncline (Fig. 5) is unconformably overlain by the Wilcolo Sandstone and, together with the Yarloo Shale, is herein assigned to the Aruhna Subgroup (Dyson 1996b). The Yarloo Shale is in turn unconformably overlain by the Wearing Dolomite and, together with the Wonoka Formation, is assigned to the Depot Springs Subgroup (Dyson 1996b).

Tent Hill Formation

The Tent Hill Formation, about 200 m thick at South Tent Hill, is an upward-sanding unit consisting of the Tregolana Shale Member, the Lincoln Gap Siltstone Member and the Corraberra Sandstone Member (Fig. 3). It is gradationally overlain by the Simmens Quartzite.

Tregolana Shale Member

The Tregolana Shale Member consists of laminated to thin-bedded, very fine to fine-grained, dark greyish brown sandstone interbedded with greyish red shale (Fig. 6). It is about 60 m thick.

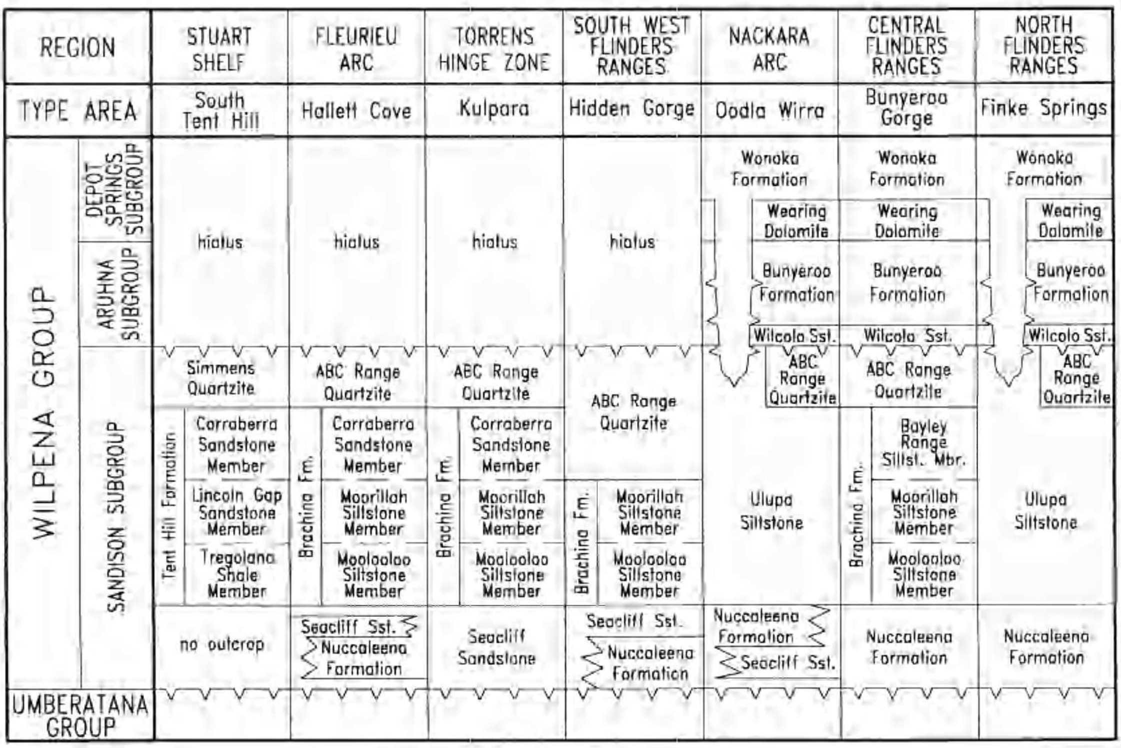


Fig. 5. Nomenclature and correlation of the Sandison Subgroup (after Dyson 1995[1]).

Fig. 6. Shale and very thin to thin-bedded fine-grained sandstone, Tregolana Shale Member of the Tent Hill Formation.

Individual sandstone beds are flat-based with occasional grooves and scratches. Internally, the sandstones display parallel lamination and current ripple cross-lamination analogous to the Bouma sequence for turbidites and are interpreted as having been deposited at or below storm wave base from waning, unidirectional currents of storm origin. Siltstone beds are characterised by parallel lamination. The thickness and frequency of the sandstone beds increases up-section as the Tregolana Shale Member grades into the Lincoln Gap Siltstone Member. The Tregolana Shale Member was deposited below storm wave base and is a lateral equivalent of the Moolooloo Siltstone Member of the Brachina Formation.

Lincoln Gap Siltstone Member (new name)

The name for this new member of the Tent Hill Formation is derived from "Lincoln Gap", 24 km south of South Tent Hill. It resurrects, in part, the former "Lincoln Gap Flagstones" of Miles (1955) that was previously used to include the sandy succession above the Tregolana Shale. Here, the Lincoln Gap Siltstone Member is used to describe the lower half of the Corraberra Sandstone Member that was originally defined by Thomson (1965). It is about 40 m thick and consists of interbedded greyish red shale and thin to medium-bedded, fine-grained greyish brown sandstone. Flute casts and scratch marks are common at the base of sandstone beds suggesting current transport to the east (Fig. 7). Internally, the sandstones commonly display horizontal planar lamination. They are, in places, capped by interference ripples or asymmetrical ripples with sinuous crests. Sandstones displaying planar lamination or hummocky cross-stratification (HCS) are capped by near-symmetrical ripples. Crests of the near-symmetrical ripples show a hexagonal pattern or are straight to wavy with tuning-fork bifurcations.

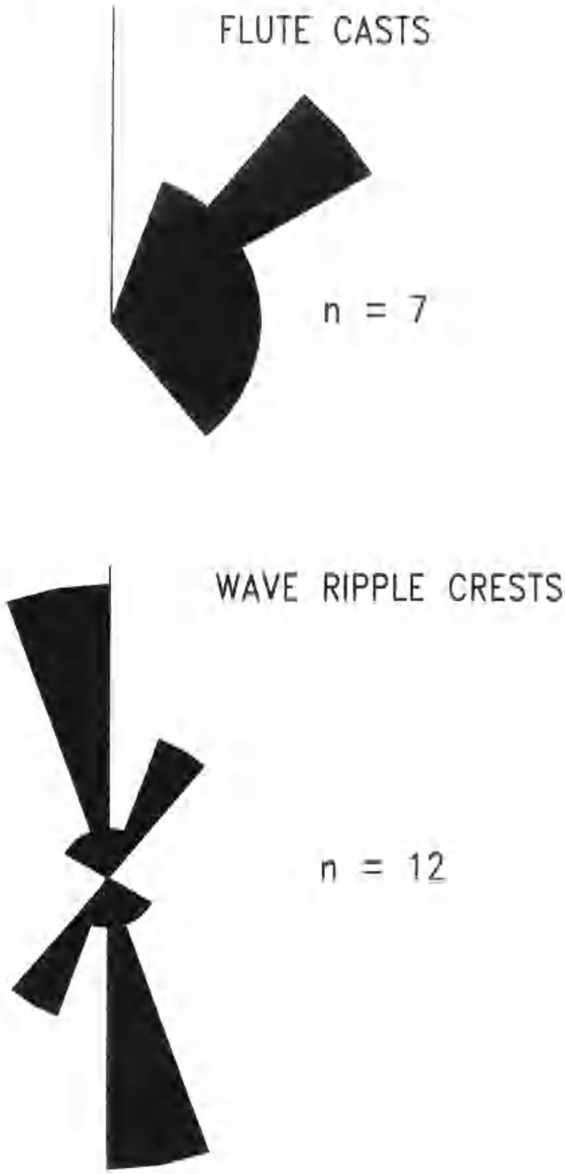


Fig. 7. Palaeocurrent data for the Lincoln Gap Siltstone Member.

Planar-laminated sandstone beds capped by current ripples are interpreted as Bouma BC sequences and suggest deposition at or below storm wave base in a current-dominated environment. The flute casts suggest the influence of unidirectional currents that were directed off-shore (Fig. 7). Ripple marks on top of these sandstone beds indicate the influence of unidirectional and oscillatory currents, resulting in combined-flow ripples (Fig. 8). The presence of

Fig. 8. Combined-flow ripples on top of fine-grained sandstone, Lincoln Gap Siltstone Member. The ripple crests show imperfect bifurcation and note the presence of wrinkle marks.

HCS and planar lamination indicates that storms were responsible for the generation of both unidirectional and oscillatory currents. Near-symmetrical ripples are interpreted as wave-formed in origin. The orientation of wave ripples suggests a north-south palaeoshoreline. These structures suggest deposition above storm wave base but below fairweather wave base. The Lincoln Gap Siltstone Member represents deposition in an environment where oscillatory currents were dominant over unidirectional currents. It is a lateral equivalent of the Moorillah Siltstone Member of the Brachina Formation and is sharply overlain by the Corraberra Sandstone Member.

Fig. 9. Chocolate-brown sandstone of the Corraberra Sandstone Member in the centre-foregound, gradationally overlain by quartzarenites of the Simmens Quartzite.

Corraberra Sandstone Member

The Corraberra Sandstone Member is about 25 m thick and consists of greyish red, iron-stained, fine to medium-grained sandstone (Fig. 9) interbedded with greyish brown shale. The sandstone beds are commonly micaceous and display heavy mineral lamination, swaley cross-stratification (Fig. 10), quasi-planar lamination (Fig. 11) and medium-scale cross-bedding. They are, in places, capped by symmetrical and asymmetrical ripples, interpreted as wave and current ripples, respectively. Glauconite, intraformational mud clasts, mud drapes, foreset bundles, climbing ripple cross-lamination and herringbone cross-lamination are also present. Several upward-sanding cycles, commonly about 5 m thick, are present in the Corraberra Sandstone Member where swaley cross-stratified sandstone beds are commonly erosive into underlying cycles that comprise tidal sand sheets. The Corraberra Sandstone Member grades upward into the Simmens Quartzite (Figs 3, 9).

The lamination and cross-stratification styles within the Corraberra Sandstone Member suggest initial deposition at or above fairweather wave base in a shoreface environment where oscillatory-dominant storm currents were operative. Cross-bedding near the top of the unit suggests the increasing influence of tidal currents. A tidally-influenced marine environment is also indicated by the presence of glauconite, bipolar cross-lamination and foreset bundles. The disconformity at the base of the Corraberra Sandstone Member marks the onset

Fig. 10. Medium-grained sandstone of the Corraberra Sandstone Member displaying SCS. Hammer for scale.

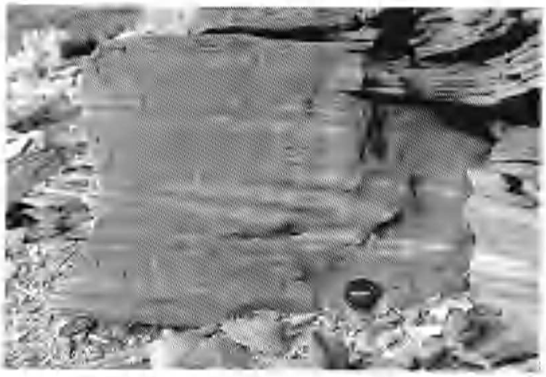


Fig. 11. Quasi-planar lamination in medium-grained sandstone, Corraberra Sandstone Member. Note presence of low-angle cross-bedding showing palaeoflow to the right. Lens cap is 52 mm in diameter.

Fig. 12. Quartzarenite of the Simmens Quartzite displaying overturned cross-bedding of tidal origin and SCS. Note small-scale herringbone cross-bedding at base of bed, Brunton compass for scale.

of forced regression in the Sandison Subgroup and metre-thick, swaley cross-stratified sandstone beds are interpreted as forced regressive deposits (Dyson 1995[1],1996a). Upward-shallowing cycles are interpreted as parasequences in the terminology of Van Wagoner (1985). On the Stuart Shelf, the Corraberra Sandstone Member represents partial lateral equivalents of the lower ABC Range Quartzite and upper Brachina Formation from the Adelaide Geosyncline. The iron-rich facies are similar to equivalents that crop out east of the Torrens Hinge Zone at Kulpara, Ochre Cove, Hallett Cove and Puttapa Gap (Fig. 1). It is thought that the iron was derived from erosion of the Mesoproterozoic Pandurra Formation on the Gawler Craton.

Simmens Quartzite

The Simmens Quartzite is about 100 m thick and consists of grey to greyish-white, fine to medium-grained, thin to very thick-bedded quartzarenite. These beds contain various clasts of volcanic and granitic composition, varying in size up to 20 mm. Compound cross-bedded sets comprising herringbone cross-stratification, sigmoidal cross-bedding displaying foreset bundles, planar-tabular cross-bedding, shale clasts, horizontal-planar lamination and minor swaley cross-stratification (SCS) are abundant (Figs 12, 13). Large-scale, trough cross-bedding is common (Fig. 14).

Compound cross-bedded sandstone suggests deposition of sand waves in a tide-dominated environment where asymmetry of the dominant and subordinate currents was pronounced, but bipolar currents were significant. The lack of HCS and SCS, except near the base of the Simmens Quartzite suggests shoreface deposition above fairweather wave base where tidal currents were dominant.

Fig. 13. Compound cross-bedding in quartzarenite of the Simmens Quartzite.

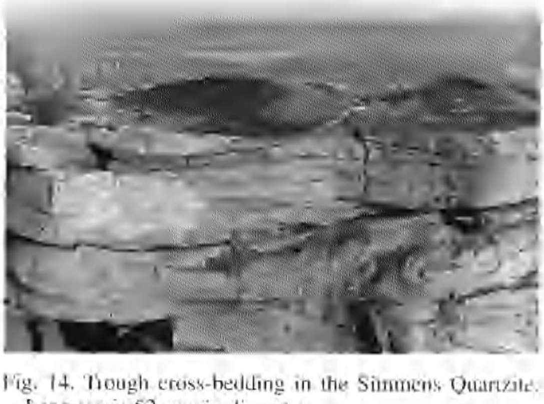


Fig. 14. Trough cross-bedding in the Simmens Quartzite. Lens cap is 52 mm in diameter.

Palaeocurrent data show a strong trend towards the east and are interpreted as reflecting progradation of ebb-flow tidal sand sheets (Fig. 15). Following Coats (1965), the Simmens Quartzite is correlated with the ABC Range Quartzite in the Adelaide Geosyncline.

Sequence boundary

The upper boundary of the Simmens Quartzite does not crop out at South Tent Hill. However, south of Bill's Lookout near the north-western side of Lake Torrens, an erosively-based sandstone at the top of the Simmens Quartzite crops out poorly where it is conformably overlain by moderate brown to greyish green shale of the Yarloo Shale. The metre-thick, medium-grained off-white sandstone contains basal clasts of shale, lithic sandstone and occasional volcanics. Sedimentary structures include trough cross-bedding, SCS and symmetrical ripples.

The erosively-based sandstone at the top of the Simmens Quartzite is interpreted as having been deposited in an estuarine environment. The style of cross-bedding in the lower part of the unit suggests deposition on a fluvially-dominated shoreface. A storm influence is indicated by the presence of SCS and the symmetrical ripples are interpreted as having been formed by wave action. This unit is a possible equivalent of the Wilcolo Sandstone that overlies the ABC Range Quartzite in the Adelaide Geosyncline where it marks the development of broad (c. 10-20 km) incised valley fills that in places attain a thickness of some 25-50 m in outcrop. They consist of a basal, trough cross-bedded facies of fluvial origin, overlain by SCS shoreface sands. The SCS shoreface sands pass rapidly upward into basinal shale of the Bunyeroo Formation. The Wilcolo Sandstone and Bunyeroo Formation together constitute the Aruhna Subgroup (Dyson 1996b). Its upper boundary is represented by the maximum flooding surface at the base of the Wearing Dolomite which is coincident with the development of kilometre-deep canyons previously assigned to the overlying Wonoka Formation (Dyson 1995[1], 1996b).

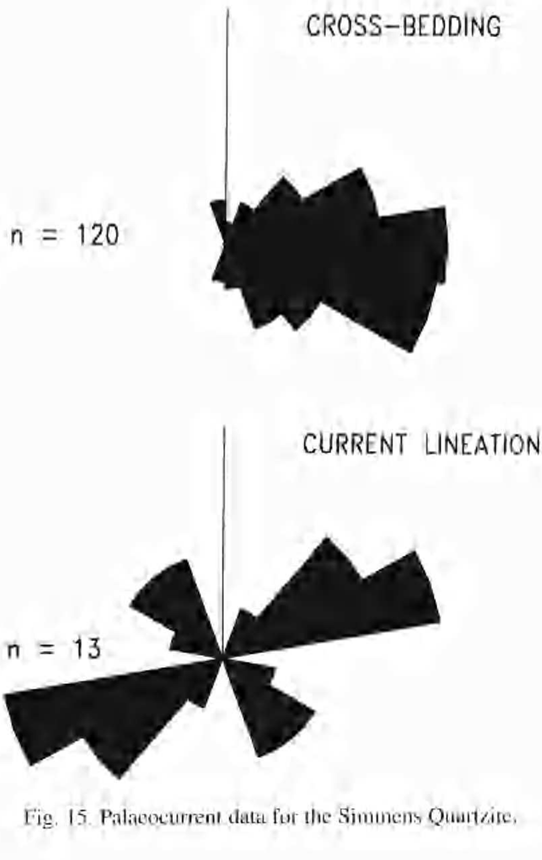


Fig. 15. Palaeocurrent data for the Simmens Quartzite.

Stratigraphic equivalents of the Tent Hill Formation and Simmens Quartzite

The redefined Tent Hill Formation and Simmens Quartzite may be considered partial lateral equivalents of the Brachina Formation, ABC Range Quartzite and Ulupa Siltstone in the Adelaide Geosyncline (Fig. 5). The Brachina Formation was defined by Dalgarno & Johnson (1964) as the thick succession of siltstone conformably overlying the Nuccaleena Formation and passing upwards into the ABC Range Quartzite (Mawson 1939). Together with the Seacliff Sandstone and Nuccaleena Formation, the Brachina Formation and ABC Range Quartzite were incorporated into the Sandison Subgroup (Dyson 1992). The Brachina Formation and ABC Range Quartzite crop out at several localities within the Mount Lofty and Flinders ranges, of which the latter occurrences appear to display lateral continuity. A study by Dyson (1992, 1995[1]) focused on well-exposed sections at Hallett Cove, Ochre Cove, Mount Terrible, Kulpara, Hidden Gorge, Wyacca Bluff, Partacoona and Bunyeroo Gorge (Fig. 1). The Ulupa Siltstone is best developed to the east and northeast parts of the Adelaide Geosyncline on the BURRA, COPLEY, OLARY, ORROROO and MARREE 1:250 000 geological sheets. The Brachina Formation and overlying ABC Range Quartzite constitute an overall upward-sanding succession. They represent regressive sedimentation of the Sandison Subgroup and are therefore defined as all the strata overlying the maximum flooding surface/downlap surface, represented by the Nuccaleena Formation, to the sequence boundary at the base of the Aruhna Subgroup.

Brachina Formation

The Brachina Formation comprises four members, each of which can be defined by its lithofacies (Fig. 5). Two of these, namely the Bayley Range Siltstone Member and the Corraberra Sandstone Member, are considered lateral equivalents (Dyson 1995[1]). The Bayley Range Siltstone Member does not crop out at Hallett Cove or Kulpara (Fig. 1). The Corraberra Sandstone Member of the Tent Hill Formation that crops out on the Stuart Shelf has an equivalent that is included in the Brachina Formation at Hallett Cove (Dyson 1995[1]). The lithofacies of the Brachina Formation at Hallett Cove display a suite of sedimentary structures suggestive of deposition under the influence of great storms. These structures, including accompanying palaeocurrent data, are illustrated and described more fully by Dyson (1995[1], 1995).

ABC Range Quartzite

The ABC Range Quartzite is composed of pale pinkish grey to greyish white, thick-bedded to massive, fine to medium-grained, slightly feldspathic quartzite and minor interbedded shale and fine-grained sandstone. It is characterised by the abundance of planar-tabular, herringbone and large-scale trough cross-bedding, asymmetrical ripples with sinuous crests, flaser and lenticular bedding, mudcracks, mud drapes and mud intraclasts. Straight-crested symmetrical ripples also cap some sandstone beds. Compound cross-bedded sets consist of small-scale cross-bedding separated by inclined, master set boundaries. As the inclination of the master bedding planes decreases, the bipolarity of the cross-bedding becomes more prevalent. Megaripple cross-bedded sets, commonly unidirectional, display a thin-thick alternation of sandy foreset bundles, bounded by reactivation surfaces, mud couplets and/or mud drapes. Sandstone channels are characterised by gently inclined lateral accretion surfaces and low-angle truncation surfaces. SCS and horizontal-planar lamination are occasionally observed near the base of some minor quartzite units. HCS is restricted to intervals of interbedded shale and thin to medium-bedded fine sandstone and quartzite. Thus, the suite of sedimentary structures in the ABC Range Quartzite described here suggests that it was deposited in a shallow marine environment where tidal currents were dominant over storm and wave action.

Ulupa Siltstone

The Ulupa Siltstone is a regionally significant unit that can be mapped over a large area of the Adelaide Geosyncline. The type section of the Ulupa Siltstone was defined by Mirams (1964) near Mount Bryan on BURRA where it was described as a succession of green, grey and locally purple shales. Plummer (1978) recognised the three members of the Brachina Formation in the Ulupa Siltstone at Oodla Wirra (Figs 1, 5) and recommended the term "Ulupa Siltstone" be relinquished. However, Forbes & Preiss (1987) proposed retention of the stratigraphic name because they argued that regional mappability of the constituent members had not been established. Lithofacies of the Ulupa Siltstone are distal equivalents of the constituent members of the Brachina Formation and are therefore time-transgressive. The Ulupa Siltstone represents regressive shallow marine sedimentation on the middle to outer shelf. Palaeocurrent data show a wide range of current directions (Dyson 1995[1]), suggesting an environment where unidirectional and oscillatory currents were interactive.

Depositional model for the Tent Hill Formation and Simmens Quartzite

The Simmens Quartzite and constituent members of the Tent Hill Formation may be defined by their lithofacies. The Tent Hill Formation is an upward-sanding succession of interbedded shale and fine-grained sandstone. Sandstone beds display several sedimentary structures associated with storm deposition such as BC Bouma sequences, HCS, micro-HCS and quasi-planar lamination. The Tregolana Shale Member was deposited below storm wave base. With progressive shallowing above storm wave base, interbedded shale and sandstone of the Lincoln Gap Siltstone Member were deposited. At the top of this succession, the Corraberra Sandstone Member consists of several sharp-based shoreface sandstones about 1-2 m thick that display SCS. These SCS sandstones are referred to as attached shoreface deposits. Some SCS sandstones are completely enclosed within shale and are referred to as detached shoreface deposits. The base of each SCS sandstone is a high-frequency sequence boundary. The erosive shoreface deposits are interpreted as forced regressive deposits. The Corraberra Sandstone Member was deposited above fairweather wave base in an environment that was storm-dominated but where tidal activity was also significant. It is gradationally overlain by parasequences of tide-dominated quartzarenites and lithic sandstones of the Simmens Quartzite. The Simmens Quartzite represents continued shallowing of the sea in which the Tent Hill and Brachina Formations were deposited. Combined with a high sediment supply, progradation of the lower shoreface resulted in a wide, shallow shelf which was conducive to tidal amplification. No submarine fan deposits have been recognised at this stratigraphic level elsewhere in the basin.

The Tent Hill Formation and Simmens Quartzite represent progradation of a tide-dominated shoreface into a storm-dominated, shallow shelf environment. This regressive succession is composed of a number of upward-sanding cycles that are contained within a hierarchy of transgressive-regressive cycles. These cycles are initially aggradational in character and become increasingly progradational upsection. A very thick offlap wedge developed from this progradation and gravitational instability resulted in extensional faulting and enhanced subsidence. Palaeocurrent data suggest a north-south, tidally-influenced shoreline. Sediment was derived from the Gawler Craton to the west and transported eastwards. The depositional environment shallowed to above fairweather wave base across a relatively narrow shelf and sediment prograded across the Torrens Hinge Zone into the Adelaide Geosyncline. Here, thickness of the Sandison Subgroup was affected by syn-depositional tectonics. Coats (1965) suggested that the overlying Wonoka Formation and Pound Subgroup were not deposited on the Stuart Shelf, but were restricted to the Adelaide Geosyncline because of syn-depositional faulting across the Torrens Hinge Zone. The arcuate trend represented by the Torrens Hinge Zone marked the possible edge of the former shelf during deposition of the lower Wonoka Formation. However, identification of the Wonoka Formation in drillcore from the eastern Stuart Shelf (e.g., Bopeechee 2) suggests that a major transgression occurred across the Torrens Hinge Zone at this time. Deposition of thick Bunyeroo sediments in the Adelaide Geosyncline was contemporaneous with active subsidence. Regional instability contributed to the incision of Wonoka canyons on the western edge of the Geosyncline.

Discussion

Forced regressive deposits

In the classic Exxon sequence stratigraphic model, the Type 1 depositional sequence consists of lowstand, transgressive and highstand systems tracts which are schematically tied to specific increments of the eustatic curve. However, an increasing volume of literature suggests that deposition during a relative fall in sea level may be placed into a fourth systems tract between the highstand systems tract (HST) and the sequence boundary. This systems tract has been previously referred to as the falling stage or forced regressive systems tract (e.g., Hunt & Tucker 1992). Study of progradational tidal sand sheets and sharp-based shoreface deposits of the Tent Hill Formation and Simmens Quartzite at South Tent Hill, and similar deposits of the Brachina Formation and ABC Range Quartzite at Hallett Cove, Kulpara, Bunyeroo Gorge and Trebilcock Gap (Fig. 1) suggests that they may be assigned to the falling stage systems tract (Dyson 1996a). These units represent regressive sedimentation of the Sandison Subgroup on the Stuart Shelf and in the Adelaide Geosyncline. The lower and upper boundaries of the the falling stage systems tract (FSST) are fixed on the relative sea level curve. However, the increments of the other systems tracts are not fixed and will vary due to subsidence rate and sediment supply. Shoreface sandstone displaying SCS at the base of the Corraberra Sandstone Member corresponds to the base of the FSST. Its upper boundary is the sequence boundary which is defined here as the lowest point of relative sea level. The correlative conformity may be analogous to the downlap surface or disconformity at the top of submarine fans in earlier Exxon models. It passes updip into the subaerial unconformity associated with the sequence boundary.

Shelf dynamics and palaeocurrents

Shoreface storm deposits of the Corraberra Sandstone Member were possibly deposited in a mesotidal environment with a tidal range of some 2-4 m. Such environments are storm or wave-dominated (Dalrymple 1992). The Corraberra Sandstone Member is directly succeeded by tidal sand sheet deposits of the ABC Range Quartzite in the southern part of the Adelaide Geosyncline. This suggests that tidal overprinting of storm and wave effects extended well out across the upper shoreface. The relative influence of storms decreased as the tidal current speeds increased, so that distal parts of the sand sheet contained storm-generated structures. The storm-dominated shoreface system was replaced by prograding tide-dominated deltas and open coast tidal flats. Mud was deposited beyond the depth and range of tidal reworking. Tidal channels within the Simmens Quartzite were possibly incised to shallow subtidal depths on the shoreface, based on the rarity of SCS. The depth of incision suggests a high mesotidal to possible macrotidal range along the palaeoshoreline. During deposition of the FSST, tidal range may have been limited due to the relative fall in sea level.

Wave ripple orientations suggest a regional north-south shoreline. Clastic material was sourced from the west. Asymmetry of the tidal regime is supported by the dominant unimodal trend for ripple cross-bedding. The wide spread of these data suggests that longshore currents were operative. Shoaling fairweather and storm waves initiated longshore currents that transported sand on the shoreface, roughly parallel to the shoreline. Palaeocurrent data from storm-influenced lithofacies in the Brachina Formation at Hallett Cove are described by Dyson (1995', 1995).

Lithofacies relationships and correlations

The Corraberra Sandstone Member of the Tent Hill Formation at South Tent Hill and on the Stuart Shelf comprises the lower part of the sandy succession overlying the Tregolana Shale Member (Crawford 1964). Lithofacies resembling those of the Corraberra Sandstone Member also crop out at Ochre Cove (Dyson 1995[1]), Hallett Cove and Kulpara (Dyson 1992) and at Puttapa Gap near Beltana (Coats 1965). Granular, medium to coarse-grained sandstone and dark red to reddish brown shale at Ochre Cove (Fig. 1), previously identified as Bunyeroo Formation (Dyson 1992), was reinterpreted as lithofacies of the Corraberra Sandstone Member of the Brachina Formation (Dyson 1995[1]). At Kulpara, facies of the Corraberra Sandstone Member are interbedded with the lower ABC Range Quartzite. The Bayley Range Siltstone Member crops out north of Pichi Richi Pass at Middle Gorge, Partacoona, Warrakimbo Gorge, Black Gap, Bunyeroo Gorge, Brachina Gorge and Finke Springs (Fig. 1). South of Partacoona and adjacent to the Torrens Hinge Zone, the storm-dominated facies of the Corraberra Sandstone Member are predominant. This suggests that the Corraberra Sandstone and Bayley Range Siltstone members, both deposited above fairweather wave base, are lateral equivalents. Furthermore, they are partial lateral equivalents of the lower ABC Range Quartzite.

The terms "Simmens Quartzite" and "ABC Range Quartzite" are used herein to describe silica-cemented quartzite or orthoquartzite in which the dominant mineralogy is over 90% quartz. Pettijohn *et al.* (1972) prefer the use of the term "quartzarenite" over "orthoquartzite" for those sediments in which the detrital fraction is 95% or more quartz. The ABC Range Quartzite has been mapped at the first appearance of thick, laterally extensive white quartzite (e.g., Webb & von der Borch 1962; Dalgarno & Johnson 1966). Apparent intertonguing of the Tent Hill Formation and Simmens Quartzite on the Stuart Shelf, and between the Brachina Formation and ABC Range Quartzite in the Adelaide Geosyncline can be generated by the stacking of these lithofacies on a parasequence scale. Similarly, intertonguing between the constituent members of the Brachina Formation and Tent Hill Formation may be explained in this manner.

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References

BROWN, H. Y. L. (1885) Report on geological character of country passed over from Port Augusta to Eucla. *Parl. Pap. S. Aust.* **45**.

COATS, R. P. (1965) Tent Hill correlations, Port Augusta and Lake Torrens areas. *Quart. Geol. Notes, Geol. Surv. S. Aust.* **16**, 9-11.

CRAWFORD, A. R. (1964) Cultana map sheet, Geological Atlas of South Australia, 1:63 360 series (Geol. Surv. S. Aust., Adelaide).

DALGARNO, C. R. & JOHNSON, J. E. (1964) Wilpena Group. *Quart. Geol. Notes, Geol. Surv. S. Aust.* **9**, 12-15.

________ & ________ (1966) PARACHILNA map sheet. Geological Atlas of South Australia, 1:250 000 series (Geol. Surv. S. Aust., Adelaide).

________, ________, FORBES, B. G. & THOMSON, B. P. (1968) PORT AUGUSTA map sheet, Geological Atlas of South Australia, 1:250 000 series (Geol. Surv. S. Aust., Adelaide).

DALRYMPLE, R. W. (1992) Tidal depositional systems pp. 195-218 *In* Walker, R. G. & James, N. P. (Eds) "Facies models: response to sea level change" (Geological Association of Canada, Ontario).

DYSON, I. A. (1992) Stratigraphic nomenclature and sequence stratigraphy of the lower Wilpena Group, Adelaide Geosyncline: the Sandison Subgroup. *Quart. Geol. Notes, Geol. Surv. S. Aust.* **122**, 7-19.

________ (1995) A model for storm sedimentation from the Neoproterozoic Brachina Formation, Adelaide Geosyncline. *PESA Journal* **23**, 51-68.

________ (1996a) A case for the falling stage systems tract - the significance of forced regressive deposits in the Neoproterozoic Sandison Subgroup. *Geological Society of Australia Abstracts* **XX** 123, *13th Australian Geological Convention, Canberra*, ACT.

________ (1996b) Stratigraphy of the Arulma and Depot Springs Subgroups. *Trans. R. Soc. S. Aust.* **120**, 101-115.

FORBES, B. G. & PREISS, W. V. (1987) Stratigraphy of the Wilpena Group *In* Preiss, W. V. (compiler) "The Adelaide Geosyncline - late Proterozoic stratigraphy, sedimentation, palaeontology and tectonics." *Bull. Geol. Surv. S. Aust.* **51**, 211-254.

HUNT, D. & TUCKER, M. E. (1992) Stranded parasequences and the forced regressive wedge systems tract: deposition during base-level fall. *Sed. Geol.* **81**, 1-9.

JOHNS, R. K. (1968) Geology and mineral resources of the Andamooka-Torrens Area. *Bull. Geol. Surv. S. Aust.* **41.**

MAWSON, D. (1939) The late Proterozoic sediments of South Australia. *Aust. N.Z. Assoc. Advmnt Sci. Rept.* **24**, 79-88.

MILES, K. R. (1955) The geology and iron ore resources of the Middleback Range area. *Bull. Geol. Surv. S. Aust.* **33**.

MIRAMS, R. C. (1964) BURRA map sheet, Geological Atlas of South Australia, 1:250 000 series (Geol. Surv. S Aust., Adelaide).

MITCHUM, JR., R. N. (1977) Seismic stratigraphy and global changes of sea level, Part 1: glossary of terms used in seismic stratigraphy *In* Payton, C. E. (Ed.) "Seismic Stratigraphy - Applications to Hydrocarbon Exploration." *Amer. Assoc. Petrol. Geol. Mem.* **26**, 205-212.

PETTIJOHN, F. J., POTTER, P. E. & SIEVER, R. (1972) "Sand and Sandstone" (Springer-Verlag, New York).

PLUMMER, P. S. (1978) Stratigraphy of the lower Wilpena Group (late Precambrian), Flinders Ranges, South Australia. *Trans. R. Soc. S. Aust.* **102**, 25-38.

THOMSON, B. P. (1965) Erosional features of the Tent Hill Formation. *Quart. Geol. Notes, Geol. Surv. S. Aust.* **13**, 4-5.

VAN WAGONER, J. C. (1985) Reservoir facies distribution as controlled by sea-level change. Abstract and poster session, SEPM mid-year meeting, Golden, Colorado, 91-92.

WEBB, B. P. & VON DER BORCH, C. C. (1962) WILLOCHRA map sheet, Geological Atlas of South Australia, 1:63 360 series (Geol. Surv. S. Aust., Adelaide).